A Panadapter for Your Transceiver or Receiver

View your IF bandwidth on your PC, tablet, or smartphone using plug-together parts and SDR software.

Jim Kocsis, WA9PYH

A panadapter is essentially a spectrum analyzer that connects to the IF of your receiver and shows activity on the currently selected band. After investing in a software-defined radio (SDR) dongle, some software, and an upconverter, my TEN-TEC Eagle transceiver now sports a panadapter, which can display band activity on a PC, tablet, or smartphone. With it, I can see empty spots to call CQ, and I can see activity even if I'm not tuned to a lone station on the band. All the visible signals move as I tune the receiver, and sensitivity is such that if I can hear them, then I can see them.

You can turn your PC, Android tablet, or smartphone into a panadapter based on the SDR dongle using the RTL2832U interface and R820T tuner chips.[1] Use *HDSDR* (High-Definition Software-Defined Radio), a feature-rich piece of software, to display results on a PC.[2] For smaller screens, such as tablets or smartphones, operating with the Android OS, you can use *SDR Touch*.[3] The total cost for any of the three configurations is well under $100. Figure 1 shows an *HDSDR* presentation of the spectrum 100 kHz on either side of the 7.125 kHz radio dial frequency.

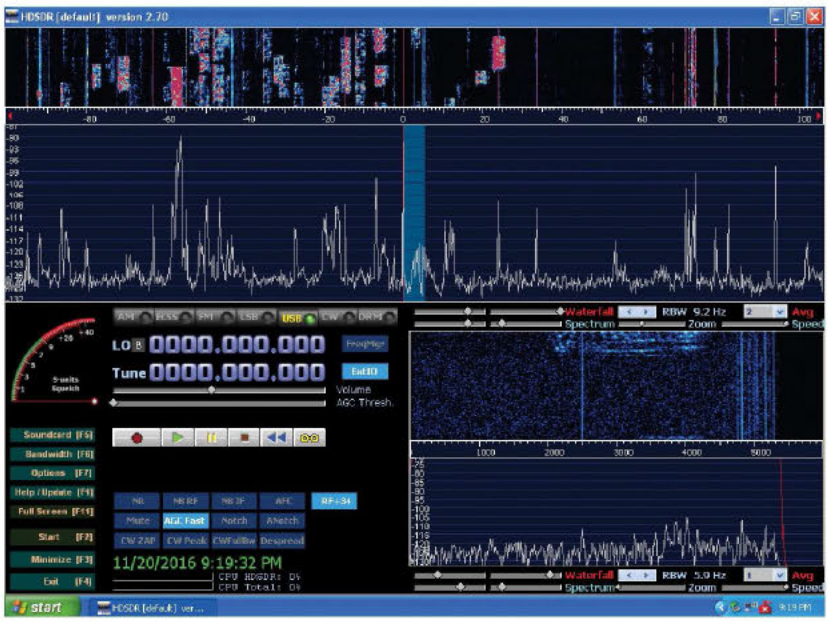

Figure 1 — PC-based *HDSDR* software shown displaying signals on 100 kHz either side of 7150 kHz.

Getting Started

You must first make sure that your hardware is up to the task. *HDSDR* must work on your PC without exceptions. *SDR Touch* needs to work with your tablet or smartphone.

The author of *SDR Touch* provides a free version that you can use to make sure your tablet or smartphone works with this SDR and software. The free version tunes only the FM broadcast band for 1 minute. From the Google Play Store, download *SDR Touch* and the driver for the SDR RTL2832U interface. The driver appears next to *SDR Touch* in the Google Play Store. After installing them, touch on the *SDR Touch* icon, then the "power on" symbol — a circle with a vertical line inside. You should see a pop-up referring to the RTL2832U driver, then click USE BY DEFAULT and OK. If the program begins running — the spectrum and waterfall display appears — you are done with the test, and you can use JUMP to set the frequency to a local FM station to see it actually working. You get 60 seconds to tune in a station and listen to the audio "to verify that the tablet/smartphone can serve as a USB host" with the free version of the software. Once you verify

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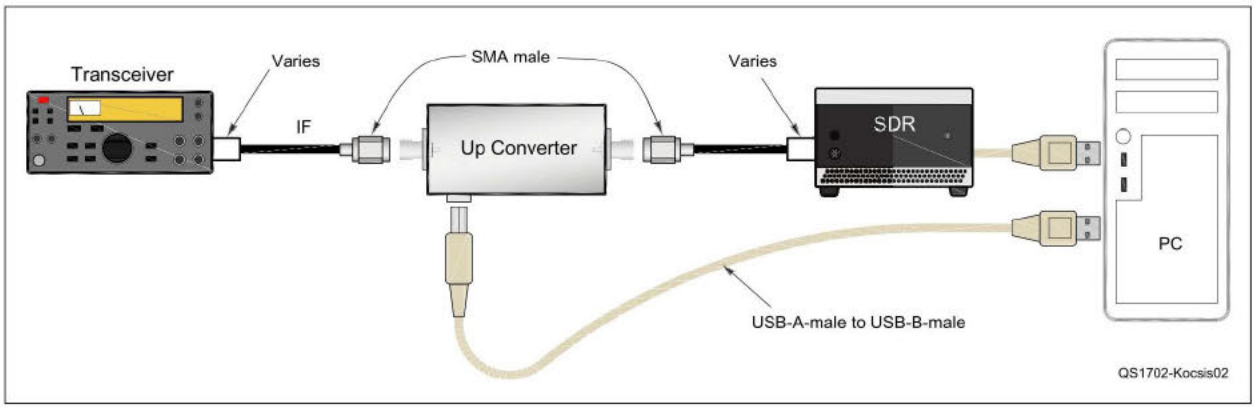

Figure 2 — Block diagram of the PC-based panadapter.

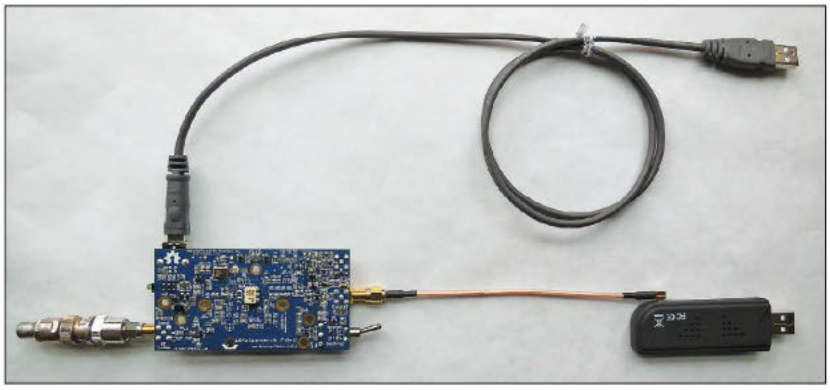

Figure 3 — PC-based panadapter hardware connected according to the diagram of Figure 2. The NooElec upconverter circuit board with a 125 MHz local oscillator is on the lower left.

that everything works with the demo version, purchase the *SDR Touch Key* for about $10 at the Google Play Store. If you do not see the FM band appear, then your tablet/smartphone is not compatible.

Next, determine the IF frequency of your receiver or transceiver to find out if you need an upconverter. My TEN-TEC Eagle's IF is 9 MHz and is provided at an RCA connector labeled AUX 1 at the back panel. Other rigs may have the IF signal provided elsewhere. If the IF signal is not provided by the manufacturer, you will have to determine where to tap into the rig. Please be very careful — I assume no responsibility for your work. I suggest using a length of RG-174 coax to get the signal outside the enclosure.

Some modern rigs have a first IF of 65 MHz. If your rig has a high IF that the SDR can tune — above approximately 30 MHz — you may not need an upconverter. If you need an upconverter to shift the IF up into a range that the SDR can tune, make sure its local oscillator (LO) is 125 MHz, not 100 MHz.[4] With a 100 MHz LO, strong local FM broadcast stations can leak through and appear on the display.

Hardware Components and Wiring

Different hardware configurations are required, depending on whether you use a PC, tablet, or smartphone.

SDR Antenna Connector

Both of my SDRs came with a small whip antenna, cable, and connector that fits the special SDR RF input connector. Instead of buying an expensive SMA for the RF connector, simply cut off the cable at the whip antenna and solder that coax directly to the upconverter output connection on the board. You don't need to remove the SMA connector on the upconverter board.

A PC Running HDSDR

Figure 2 shows the configuration, and Figure 3 shows the hardware ready for connecting to a PC and the radio. This configuration requires two USB ports — one for communication with the SDR and one to power the upconverter, if one is needed. Use a USB 2.0 A-male to B-male cable to power the upconverter initially.[5]

HDSDR is a powerful piece of software and it is free. Follow the instructions at **http://hdsddr.de/RTLSDR_with_HDSDR.pdf** exactly. Click on OPTIONS, RF FRONT-END + CALIBRATION, INDEPENDENT TUNE IN SDR, SDR HARDWARE ON DOWN/UPCONVERTER, and enter 125000000. I added my IF frequency of 9 MHz to the 125 MHz upconverter LO frequency, and entered 134000000 to make the spectrum display the radio dial frequency plus and minus relative to the display center. Set the AGC to fast and RF gain to 25 dB initially. Click START to run. There are many other settings under OPTIONS for time stamps, colors, and much, much more.

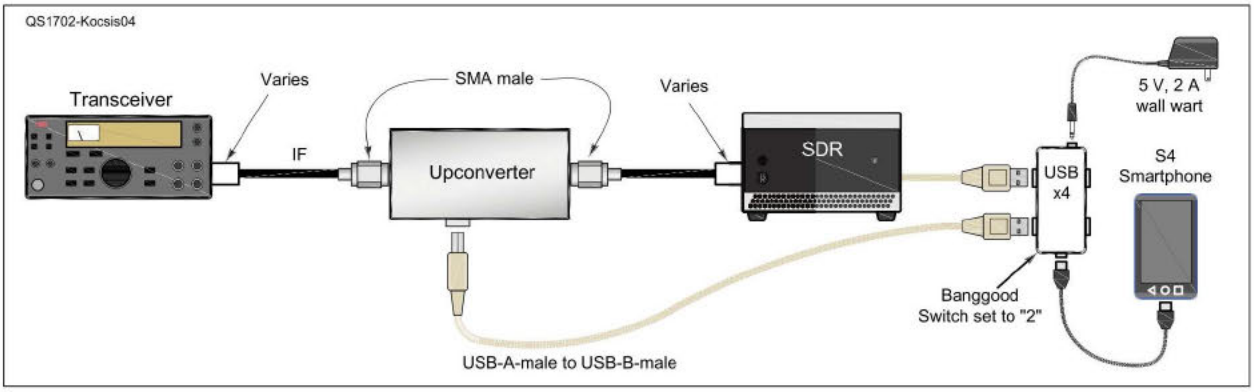

Figure 4 — Block diagram of the panadapter powered by a USB hub, and running *SDR Touch* software on a Samsung S4 smartphone.

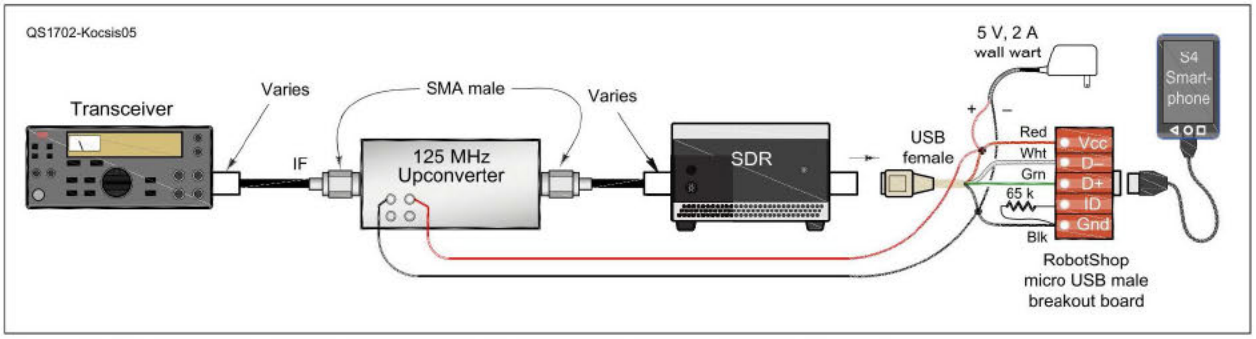

Figure 5 — Block diagram of the panadapter powered by a homebrew adapter, and running *SDR Touch* on a smartphone.

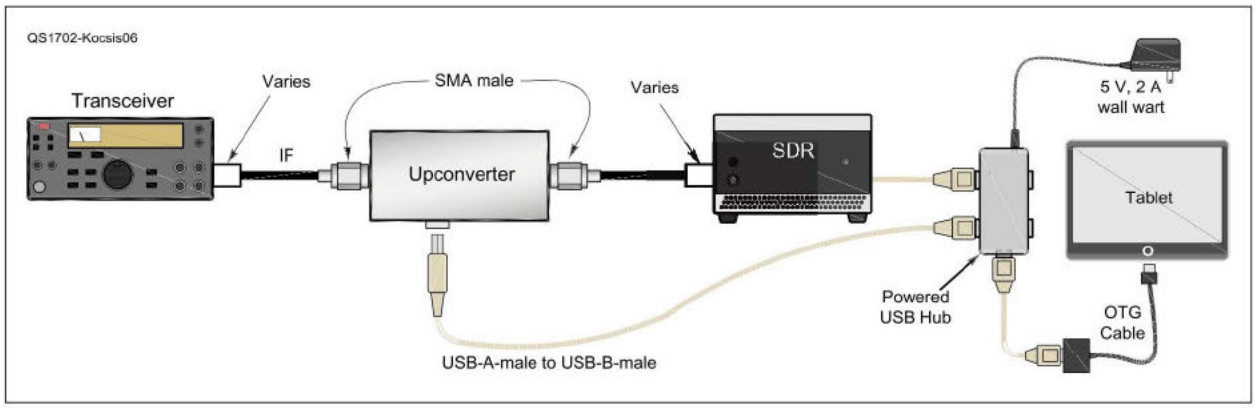

Figure 6 — Block diagram of the panadapter powered by a USB hub. A 5 V supply powers the hub, which in turn powers the SDR and upconverter, but does not charge the tablet.

A Smartphone Running SDR Touch

Figure 4 shows a diagram of the configuration for a Samsung S4 smartphone using *SDR Touch* software. Images of the hardware are on the *QST* in Depth web page.[6] *SDR Touch* is CPU-intensive and can drain the S4 battery quickly. One solution is to use a four-port micro USB OTG charger hub cable for a tablet adapter.[7] Be sure to use an adapter compatible with your tablet or smartphone.

A second option is to make your own OTG/charge cable assembly according to the diagram in Figure 5. The trick to getting the charge and communications to run at the same time is to use Pin 4 on the micro USB male

connector that goes to the S4 USB port. Normally, Pins 1, 2, 3, and 5 — Vcc, D-, D+, ID, GND, respectively — are used for communications and power. To charge and communicate at the same time, connect a resistor between ID Pin 4 and GND Pin 5. The resistor causes the S4 to charge *and* communicate. Use 65 kΩ for the S4 smartphone. Other resistor values that I found online are 100 kΩ for a Sony tablet, 20 kΩ for a Samsung tablet, and 124 kΩ for other brands of tablets.

In the Figure 5 configuration, I used a 5 V, 2 A wall wart power supply instead of the micro USB connector to charge the smartphone and power the upconverter. The 5 V power supply is wired across the V+ and GND, and 5 V is wired directly to the upconverter board on the side opposite the connector.

In the PC configuration of Figure 1 with a USB-A-male to USB-B-male cable plugged in to a USB port on the PC, measure the solder joints with a voltmeter to determine which are the +5 V and GND connections. Solder a pair of small wires to the two pins and route them to the upconverter board.

SDR Touch requires that you enter the LO offset when using an upconverter. However, you cannot have it display zero at the center like in *HDSDR*. Just remember that to the left of center is activity *above* and to the right is activity *below* your radio dial frequency. My SDR/upconverter combination shows the IF at 8.988 MHz instead of 9.000 MHz, so expect to adjust the tuning frequency a bit to center the display. Alternately, you can adjust the 125 MHz offset a bit to compensate. Let the SDR warm up, because its tuning will change a bit with temperature. The interface is the touchscreen, so tuning is a bit touchy. Instead of sliding the display, it's easier to set the frequency via the pop-up keypad using the JUMP button. Initially, the bandwidth is 1 MHz. Use two fingers to stretch the display so that you see 100 kHz or less on either side of the tuning frequency to get really good resolution. There is a small triangle at the bottom of each side to move the menu off the screen. Turn off the ROTATE feature on your device, or else the bandwidth will be set back to 1 MHz when the unit is physically rotated. My S4 runs warm to the touch when using this app, but I have experienced no problems.

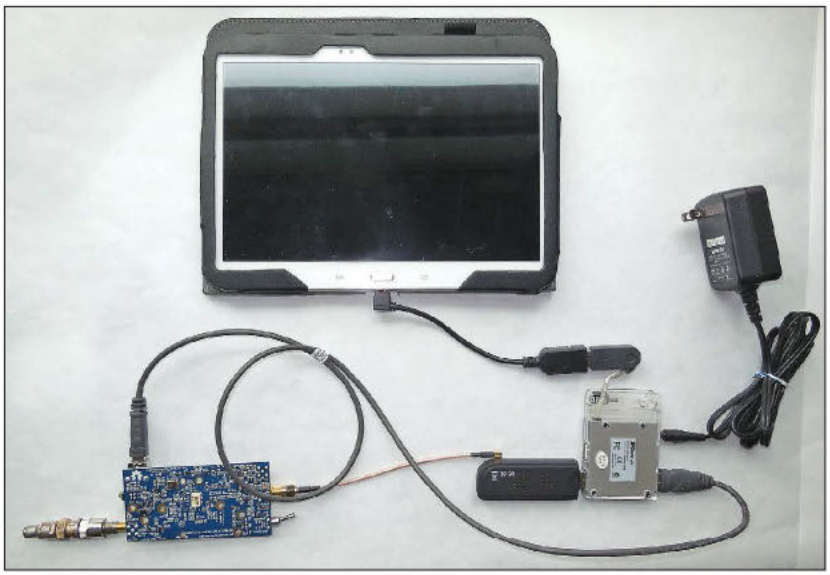

Figure 7 — Tablet-based panadapter hardware corresponding to the diagram of Figure 6. The NooElec upconverter circuit board is on the lower left.

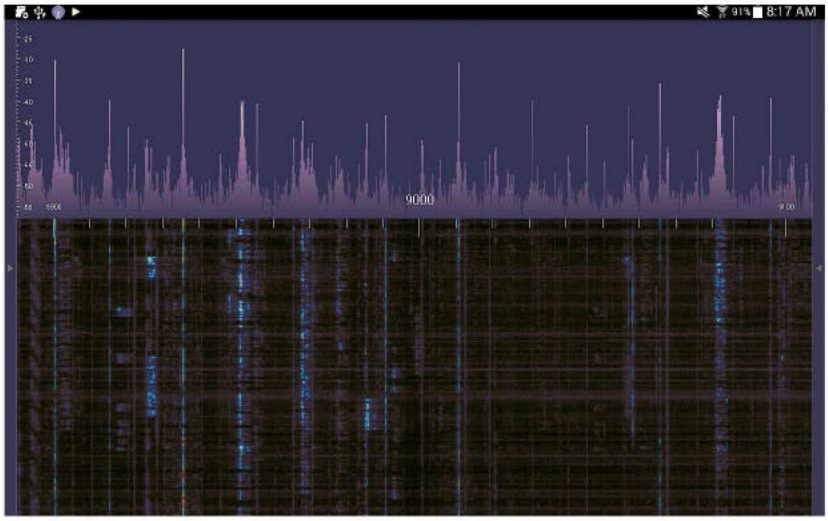

Figure 8 — *SDR Touch* running on a tablet shows SSB signals to the left of the 9 MHz IF center frequency, and CW signals on the right.

A Tablet Running SDR Touch

Figure 6 shows the *SDR Touch* setup on my Samsung Tab 3 10-inch tablet. Figure 7 shows the corresponding hardware configuration, and Figure 8 shows a screen capture of the tablet display.

Unfortunately, I was not able to make the powered USB hub adapter, or my homebrew patch cable, simultaneously charge the battery, *and* communicate with the tablet to *SDR Touch*. Samsung technical support was also unable to help me accomplish this.

On the bright side, the battery in the Tab 3 is substantial, and I was able to get more than 2.5 hours of use with the display brightness set to one-third full scale. Be sure to turn off rotation,

If you need an upconverter to shift the IF up into a range that the SDR can tune, make sure its LO is 125 MHz, not 100 MHz.

Wi-Fi, Bluetooth, GPS, and so on to conserve battery energy. I'm continuing to look for a way to simultaneously charge the battery and communicate with the tablet. The remainder of the setup is the same as on a smartphone; however, I use a powered USB hub so the battery doesn't have to power the SDR or upconverter — every little bit helps. My Samsung tablet runs cool, unlike the S4.

Summary

By far, *HDSDR* offers the best display. You can zoom in on the band and identify SSB, CW, PSK, and CW pileup signals. I learned a lot while developing this receiver add-on. It was frustrating at times, but the final result is well worth the effort.

Additional screenshots of *HDSDR* and photos of the hardware configurations are available on the *QST* in Depth web page.

I plan on attaching this panadapter to my VHF/UHF satellite radio IF signal to observe the passband of a linear transponder-type satellite. The PC must be able to run both *HDSDR* and *SatPC32* satellite tracking, VFO control, and antenna position calculation simultaneously. I'm sure that the newer PCs will be up to that task.

Final Words

I've spent hours just watching the bands instead of operating. Now that I'm somewhat used to it, I plan to get back on the air! If you find a way to simultaneously charge and run *SDR Touch* on the Samsung Tab 3 please let me know so we can get the word out to all those with the Tab 3. I would appreciate hearing from anyone using the configuration as a panadapter.

A big thank you to my wife, Yvonne, for putting up with the hours I spent getting this to work, sharing in my excitement the first time I got it working, and for proofreading this text. The S4 I use now was her old smartphone. I likely will *not* get permission to experiment with her new Samsung S7!

Notes

[1]NooElec R820Tm SDR dongle, available at **www.nooelec.com/store/sdr/nesdr-mini-rtl2832-r820t.html**.

[2]Download *HDSR* software from **www.hdsdr.de**.

[3]Download *SDR Touch* software from **SDRTouch.com/download.php**.

[4]Ham It Up v1.3 – RF Upconverter for Software Defined Radio, available at **www.nooelec.com/store/ham-it-up.html**.

[5]Monoprice 3-feet USB 2.0 A-Male to B-Male 28/24AWG cable, item 105437, available on **www.amazon.com**.

[6]**www.arrl.org/qst-in-depth**

[7]**www.banggood.com/search/4-port-micro-usb-otg-charger-hub-cable-for-tablet.html**

Photos by the author.

Jim Kocsis, WA9PYH, holds an Amateur Extra class license, and has been a ham since April 1964. He is retired from Honeywell Aerospace, where he was a Test Engineer in their Environmental Test Laboratory. Jim enjoys building or modifying nearly anything for ham radio. He operates mostly HF CW, but gets on SSB occasionally. He spends time outdoors riding a bicycle non-competitively with his handheld along to listen to the local repeaters. Jim's articles have appeared in *QST*, *QEX*, *CQ*, *73*, and the *AMSAT Journal*. He operates through the Amateur Radio satellites occasionally and is a member of AMSAT. You can reach Jim by e-mail at **wa9pyh@arrl.net**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Strays

US Virgin Islands Jubilee Project

On March 31, 1917, the United States presented a warrant for 25 million dollars in gold to Danish Minister Constantine Brun to purchase what would come to be known as the US Virgin Islands. Throughout 2017, the Skanderborg (Denmark) Amateur Radio Club will be celebrating the 100th anniversary of the sale with the special event call sign OZ100DVI and offering a commemorative QSL card. For more information, see **oz100dvi.oz7skb.dk**.

QST Congratulates...

Allison Bright, W0ACB, of Saint Clair, Missouri, who was the subject of a feature article in the November/December 2016 issue of *Discovery Girls* magazine (a magazine specifically for girls age 8 and up). Her father, Jeremy Bright, KB0MUY, appeared with her in one of the article photos. Proud grandfathers in the Saint Louis area are Bill Brown, KK2G, and Charlie Bright, WE0R.